

What is claimed is:

1. A method of path routing in a network, said method comprising the steps of:
  - 5 receiving link state advertising information generated by nodes within said network, said link state advertising information utilized to derive the bandwidth available on a particular link for protection paths, protected paths and unprotected paths;
  - performing a first search for a path using only links having sufficient bandwidth available of a type the same as that of the path to be found to accommodate said path; if said first search is not successful then,
- 10 performing a second search for a path using only links having sufficient combined bandwidth available reserved for protected paths and unprotected paths to accommodate said path; if said second search is not successful then,
  - performing a third search for a path using only links having sufficient combined bandwidth available reserved for protection paths, protected paths and unprotected paths to accommodate said path; and
- 15 configuring appropriate nodes within said network in accordance with the path found.

2. The method according to claim 1, wherein the bandwidth available reserved for protection paths represents the bandwidth of a link that is saved for protection path uses and that is not currently allocated for non-protection paths.
- 20 3. The method according to claim 1, wherein said type comprises bandwidth available for unprotected paths if the path to be found is to use bandwidth reserved for unprotected paths.
4. The method according to claim 1, wherein said type comprises bandwidth available for protected paths if the path to be found is to use bandwidth reserved for protected paths.
- 25 5. The method according to claim 1, wherein said link state advertising information comprises one or more type, length, value (TLV) objects flooded using a link state routing protocol, wherein said one or more TLVs optionally function as sub-TLVs of other TLVs.

6. The method according to claim 1, wherein said routing protocol is chosen from the group comprising the Open Shortest Path First (OSPF) protocol, OSPF extensions, OSPF-TE or OSPF-TE extensions.

7. The method according to claim 1, wherein said routing protocol comprises the  
5 Intermediate System to Intermediate System (ISIS) protocol or any extensions thereof.

8. The method according to claim 1, wherein said routing protocol comprises the Private Network to Network Interface (PNNI) protocol or any extensions thereof.

9. The method according to claim 1, wherein said link state information relating to the bandwidth available on a particular link is apportioned in accordance with a plurality of  
10 classes for the available bandwidth of said protection paths, a plurality of classes for the available bandwidth of said protected paths and a plurality of classes for the available bandwidth of said unprotected paths.

10. The method according to claim 1, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth available for protected-LSPs, a second TLV adapted to indicate bandwidth available for  
15 unprotected-LSPs and a third TLV adapted to indicate total available bandwidth.

11. The method according to claim 1, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth available for protected-LSPs for a plurality of classes, a second TLV adapted to indicate  
20 bandwidth available for unprotected-LSPs for a plurality of classes and a third TLV adapted to indicate total available bandwidth for a plurality of classes.

12. The method according to claim 1, wherein said first search, said second search and said third search are performed utilizing the Dijkstra algorithm.

13. The method according to claim 1, wherein said the configuration of nodes within said network utilizes Reservation Protocol (RSVP) signaling, RSVP-TE or any extensions thereof.  
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14. The method according to claim 1, wherein said the configuration of nodes within said network utilizes LDP signaling, CR-LDP or any extensions thereof.

15. The method according to claim 1, wherein said step of configuring nodes within said network comprises configuring the Multiprotocol Label Switching (MPLS) forwarding within the nodes.

5 16. The method according to claim 1, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected paths in response to changes in network topology.

17. The method according to claim 1, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected paths in response to changes in the link state of said network.

10 18. A method of path routing in a network, said method comprising the steps of: receiving link state advertising information generated by nodes within said network, said link state advertising information utilized to derive the bandwidth available on a particular link for protection paths and non-protection paths; performing a first search for a path using only links having sufficient bandwidth

15 available reserved for non-protection paths to accommodate said path; if said first search is not successful then,

performing a second search for a path using only links having sufficient combined bandwidth available reserved for protection paths and non-protection paths to accommodate said path; and

20 configuring appropriate nodes within said network in accordance with the path found.

19. A method of routing unprotected Label Switched Paths (LSPs) in a network, said method comprising the steps of:

receiving link state advertising information generated by nodes within said network, said link state advertising information utilized to derive the bandwidth available on a particular link for protection paths, protected paths and unprotected paths;

25 performing a first search for a path using only links having sufficient available bandwidth for unprotected paths to accommodate said path; if said first search is not successful then,

performing a second search for a path using only links having sufficient combined available bandwidth for protected paths and unprotected paths to accommodate said path; and if said second search is not successful then, performing a third search for a path using only links having sufficient combined available bandwidth for protection paths, protected paths and unprotected paths to accommodate said path.

5 20. The method according to claim 19, further comprising the step of configuring appropriate nodes within said network in accordance with the path found.

10 21. The method according to claim 19, wherein the bandwidth available reserved for protection paths represents the bandwidth of a link that is saved for protection path uses and that is not currently allocated for non-protection paths.

22. The method according to claim 19, wherein said link state advertising information comprises one or more type, length, value (TLV) objects flooded using a link state routing protocol, wherein said one or more TLVs optionally function as sub-TLVs of other TLVs.

15 23. The method according to claim 19, wherein said routing protocol is chosen from the group comprising the Open Shortest Path First (OSPF) protocol, OSPF extensions, OSPF-TE or OSPF-TE extensions.

24. The method according to claim 19, wherein said routing protocol comprises the Intermediate System to Intermediate System (ISIS) protocol or any extensions thereof.

20 25. The method according to claim 19, wherein said routing protocol comprises the Private Network to Network Interface (PNNI) protocol or any extensions thereof.

26. The method according to claim 19, wherein said link state information relating to the bandwidth available on a particular link is apportioned in accordance with a plurality of classes for the available bandwidth of said protection paths, a plurality of classes for the available bandwidth of said protected paths and a plurality of classes for the available bandwidth of said unprotected paths.

27. The method according to claim 19, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth

available for protected-LSPs, a second TLV adapted to indicate bandwidth available for unprotected-LSPs and a third TLV adapted to indicate total available bandwidth.

28. The method according to claim 19, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth 5 available for protected-LSPs for a plurality of classes, a second TLV adapted to indicate bandwidth available for unprotected-LSPs for a plurality of classes and a third TLV adapted to indicate total available bandwidth for a plurality of classes.

29. The method according to claim 19, wherein said first search, said second search and said third search are performed utilizing the Dijkstra algorithm.

10 30. The method according to claim 19, wherein said the configuration of nodes within said network utilizes Reservation Protocol (RSVP) signaling, RSVP-TE or any extensions thereof.

31. The method according to claim 19, wherein said the configuration of nodes within said network utilizes LDP signaling, CR-LDP or any extensions thereof.

15 32. The method according to claim 19, wherein said step of configuring nodes within said network comprises configuring the Multiprotocol Label Switching (MPLS) forwarding within the nodes.

33. The method according to claim 19, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected 20 paths in response to changes in network topology.

34. The method according to claim 19, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected paths in response to changes in the link state of said network.

35. A method of routing protected Label Switched Paths (LSPs) in a network, said 25 method comprising the steps of:

receiving link state advertising information generated by nodes within said network,  
said link state advertising information utilized to derive the bandwidth available on a particular link for protection paths, protected paths and unprotected paths;

performing a first search for a path using only links having sufficient available bandwidth for protected paths to accommodate said path; if said first search is not successful then,

5 performing a second search for a path using only links having sufficient combined available bandwidth for protected paths and unprotected paths to accommodate said path; and if said second search is not successful then,

performing a third search for a path using only links having sufficient combined available bandwidth for protection paths, protected paths and unprotected paths to accommodate said path.

10 36. The method according to claim 35, further comprising the step of configuring appropriate nodes within said network in accordance with the path found.

37. The method according to claim 35, wherein the bandwidth available reserved for protection paths represents the bandwidth of a link that is saved for protection path uses and that is not currently allocated for non-protection paths.

15 38. The method according to claim 35, wherein said link state advertising information comprises one or more type, length, value (TLV) objects flooded using a link state routing protocol, wherein said one or more TLVs optionally function as sub-TLVs of other TLVs..

39. The method according to claim 35, wherein said routing protocol comprises the Open Shortest Path First (OSPF) protocol, OSPF extensions, OSPF-TE or OSPF-TE extensions.

20 40. The method according to claim 35, wherein said routing protocol comprises the Intermediate System to Intermediate System (ISIS) protocol or any extensions thereof.

41. The method according to claim 35, wherein said routing protocol comprises the Private Network to Network Interface (PNNI) protocol or any extensions thereof.

25 42. The method according to claim 35, wherein said link state information relating to the bandwidth available on a particular link is apportioned in accordance with a plurality of classes for the available bandwidth of said protection paths, a plurality of classes for the available bandwidth of said protected paths and a plurality of classes for the available bandwidth of said unprotected paths.

43. The method according to claim 35, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth available for protected-LSPs, a second TLV adapted to indicate bandwidth available for unprotected-LSPs and a third TLV adapted to indicate total available bandwidth.

5 44. The method according to claim 35, wherein said link state information relating to the bandwidth available on a particular link comprises a first TLV adapted to indicate bandwidth available for protected-LSPs for a plurality of classes, a second TLV adapted to indicate bandwidth available for unprotected-LSPs for a plurality of classes and a third TLV adapted to indicate total available bandwidth for a plurality of classes.

10 45. The method according to claim 35, wherein said first search, said second search and said third search are performed utilizing the Dijkstra algorithm.

46. The method according to claim 35, wherein said the configuration of nodes within said network utilizes Reservation Protocol (RSVP) signaling, RSVP-TE or any extensions thereof.

15 47. The method according to claim 35, wherein said the configuration of nodes within said network utilizes LDP signaling, CR-LDP or any extensions thereof.

48. The method according to claim 35, wherein said step of configuring nodes within said network comprises configuring the Multiprotocol Label Switching (MPLS) forwarding within the nodes.

20 49. The method according to claim 35, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected paths in response to changes in network topology.

50. The method according to claim 35, further comprising the steps of re-calculating and re-advertising the available bandwidth for protection paths, protected paths and unprotected paths in response to changes in the link state of said network.

25 51. A network device, comprising:  
one or more line PHY line interfaces for interfacing said network device to one or more communication links;

a switch adapted to switch data between a plurality of ingress inputs and a plurality of egress outputs;

a processor;

memory means coupled to said processor;

5 software means operative on said processor for:

receiving link state advertising information generated by nodes within said network, said link state advertising information utilized to derive the bandwidth available on a particular link for protection paths, protected paths and unprotected paths;

10 performing a first search for a path using only links having sufficient bandwidth available of a first type the same as that of the path to be found to accommodate said path; if said first search is not successful then,

15 performing a second search for a path using only links having sufficient combined available bandwidth of a second type opposite of that of the path to be found to accommodate said path; and if said second search is not successful then,

performing a third search for a path using only links having sufficient protection path bandwidth available to accommodate said path.

20 52. A computer program product for use in a network device, said computer program product comprising:

a computer useable medium having computer readable program code means embodied in said medium for performing a path reroute in a network, said computer program product comprising:

25 computer readable program code means for advertising link state information utilized to derive the bandwidth available on a particular link for protection paths, protected paths and unprotected paths;

computer readable program code means for performing a first search for a path using only links having sufficient bandwidth available of a type the same as that of the path to be found to accommodate said path;

30 computer readable program code means for performing a second search, if said first search is not successful, for a path using only links having sufficient combined

bandwidth available reserved for protected paths and unprotected paths to accommodate said path; and

computer readable program code means for performing a third search, if said second search is not successful, for a path using only links having sufficient combined

5 bandwidth available reserved for protection paths, protected paths and unprotected paths to accommodate said path.

53. The method according to claim 52, further comprising computer readable program code means for configuring appropriate nodes within said network in accordance with the path found.

10 54. The method according to claim 52, wherein said first search, said second search and said third search employ the Dijkstra algorithm.